The architecture student as part of an interdisciplinary design team

An experimental design studio of architecture students and engineers

Theoretical reflections

Already in 1967 Engel is convinced that in order to design 'con-temporary' buildings, teamwork between experts in science and architecture is necessary (Engel and Rapson, 1967).This is in opposition to the architect as 'homo universalis', expert in all disciplines, designing buildings on his own. Engel believes in a collaboration where the architect generally designs the structural concept of the building and the structural engineer merely dimensions this structure.
Today it is common practice for architect and engineer[1] to work together. And beyond Engel's belief of the architect as main designer of the (structural) concept, the challenge in their collaboration lays in combining both their knowledge into a creative process where architect and engineer design together, integrating both disciplines. In this design team, the engineer has an important role as a creative contributor to the architectural design process, dealing not only with purely engineering problems, but also with architectural ones.
Such a creative interdisciplinary design team uses the knowhow of all team members, architects and engineers, during the design process. The shape of the building is then not only an aesthetical or architectural choice, but also a structural and building technical one. And thus, for their contribution to be meaningful, the engineers need to be involved early in the architectural design process.

During this early collaboration, all experts need to understand each other in order to be able to design as a team. And for this communication to be successful, the experts need to possess sufficient knowledge of the opposite discipline(s): the engineer needs to know something about architecture to understand the architectural concept, and the architect something about engineering sciences to understand the engineer's discourse. This mutually possessed knowledge on architecture and engineering science within the interdisciplinary team, enables a design process where demands and desires of the opposite discipline can be integrated in the search of a design solution within the own discipline (e.g. the engineer designing a structure for an architecture with an aggressive expression).

This kind of collaboration between architect and engineer puts a strong emphasis on their communication: it must enable the architect to guide the engineer in generating, through the engineering sciences, design proposals that enrich the overall architecture.
For example in the collaboration with the structural engineer, the architect's task lays not in designing the structural concept himself, but primarily to convey his architectural desires to the engineer, and understand the essence of the proposed structural solutions of the engineer. This requires of the architect mainly to be skilled in communicating with the engineer, and not in designing the structure, which after all is the expertise of the structural engineer. In return, this kind of collaboration demands for similar communication abilities of the engineer, and for a commitment to creatively develop design proposals within the own discipline in function of architectural demands (and not just structural demands).

If we transpose this to the education of the architect, it means that the student needs to be trained in this kind of collaboration with engineers as co-designers. The emphasis lays then less on the question if the student is for example able to design a structure, but more on how he can instigate the structural engineer to contribute to the creative process. What can the engineer do for the architecture student? How can the engineer be deployed to enrich and inspire the design process? What language does the student need to use with the engineer? How is he supposed to interpret the engineer's proposal? How is he to incorporate the engineering logics and numbers, during the evaluation of the overall design quality?

From this perspective, a research seminar has been setup in the second master year of architecture, with the following purposes:

- to confront the students with this kind of collaboration by developing experiential knowledge through the design studio.
- to investigate some of the characteristics of this interdisciplinary teamwork.
- to evaluate the pedagogical value of this experimental seminar.

[1] 'Architect' is used here as the expert in designing architectural shapes, 'engineer' as the expert in (engineering) sciences.

This research is part of my doctoral work which investigates the communication between architect and structural engineer during this interdisciplinary teamwork early in the design process.

Research Seminar Setup

With the condition of being 'sustainable' -in it its most broad interpretation-, students are asked to design an architecture office combined with a studio apartment. From the start of their design process, the students have to take into account the requirements of the building services, the construction and the structure of the building. This will enable us as researchers, to investigate the relation between the engineering sciences and the architectural design process.
In order to instigate a researching attitude, the students have to design at least three different volume studies, and evaluate them through a matrix of different criteria. Afterwards one of these studies is selected for further design refinement.
As teachers of this design studio , my colleague and I are to be consulted weekly by the students: Sandy De Bruycker as building service engineer and I as structural engineer. (We both have respectively a professional practice in this matter). This forces the students to investigate how to make these consultancy opportunities useful for their design process. These consultancy meetings are video recorded for further evaluation.
The students are required to log their design process, making them more aware of their activities and the choices they make. This logbook also gives us an insight of the student's design process.
The presented work is essentially graded for the researching attitude during the design process, rather than for the overall architectural value of the final design.

Evaluation of the seminar

The engineering perspective and the condition of sustainability, have clearly influenced the design outcome (Fig. 1). In many cases this approach has lead to very inspiring design developments. The technique to guide the design process through engineering sciences, is fundamentally the same as when it is guided through urbanism or interior design (which is more commonly applied in the design studios). Essential in this technique is to find a balance between the engineering perspective and the overall quality of the architectural design. A building technical sound design, still has to contain a clear architectural value. This implies that sometimes the compelling engineering logics, with its precise numbers and rules, have to be abandoned in order to achieve architecture. For some students this was more obvious than for others.

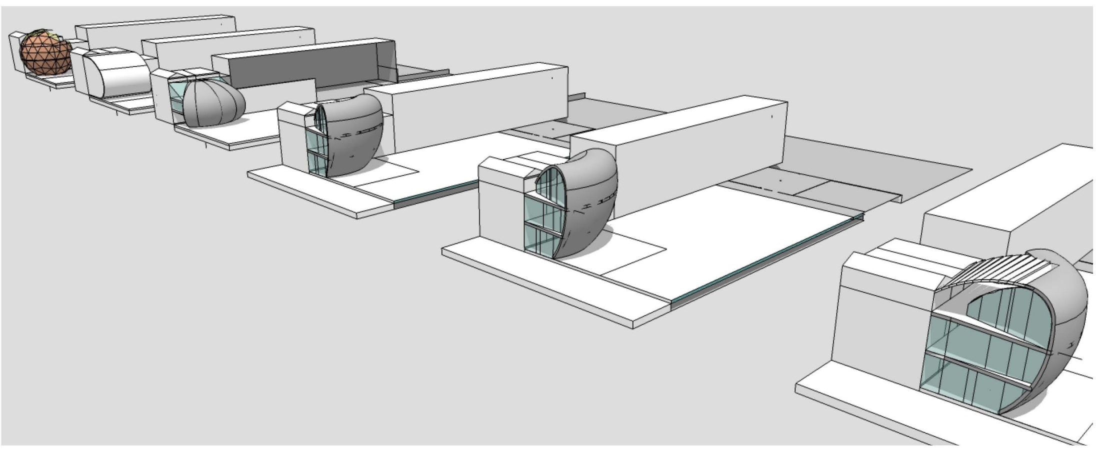


Fig. 1: Design evolution (example from the work of Hanne De Vos en Els Terryn).

An example of this, can be found in the search for a compact building in order to achieve a minimum area of heat loss for a certain volume. In free space this compact volume is a sphere. Within the engineering sciences every space in this sphere is then equal, which is not the case in an architectural space. So within the architectural discipline this mathematical formula for compactness (=Volume/Area of heat loss) makes little sense. But by investigating this mathematical compactness, the students develop however a more tacit knowledge on compactness, which meaningfully enriches their design capabilities (Fig.2).

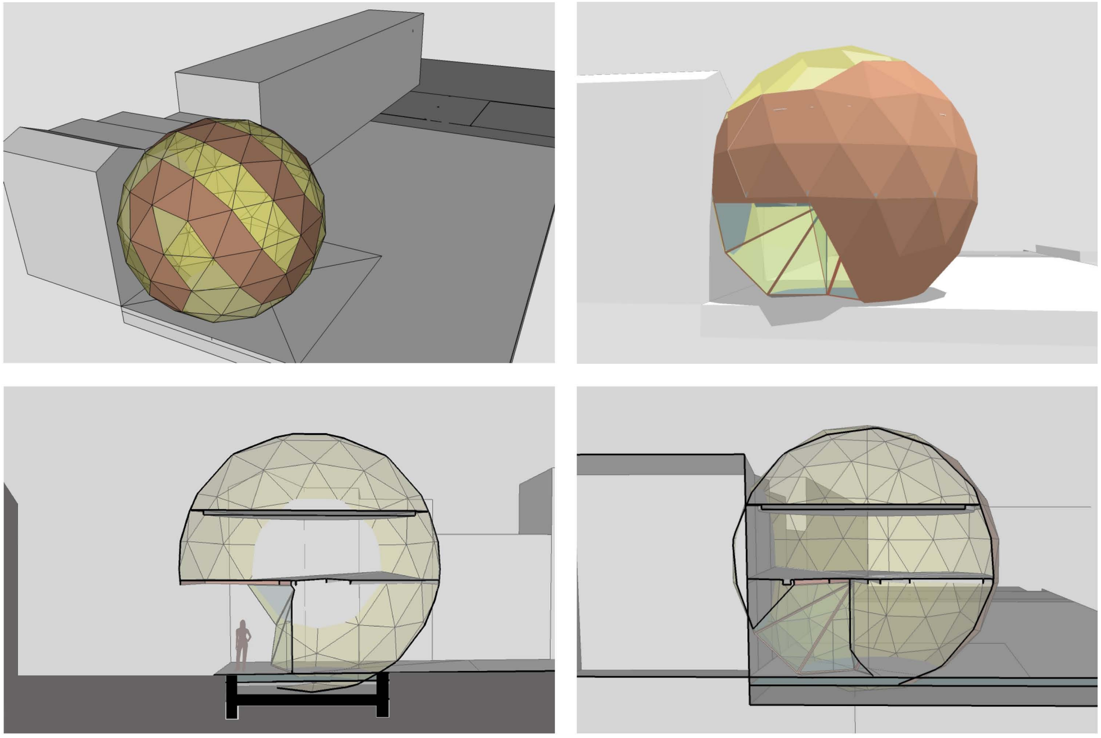


Fig. 2: Research sphere volume (example from the work of Hanne De Vos en Els Terryn).

The students are stimulated to evaluate their different design proposals by a matrix of several criteria (Fig.3). By clarifying the advantages and disadvantages of their proposals, students are not only able to justify certain design choices to others, but also to themselves, making them more confident of the design path chosen. It is remarkable that these evaluation criteria, chosen by the students, mainly deal with building technical aspects, ignoring the architectural qualities of their design. This is probably due to the imposed engineering perspective of the design studio setup.

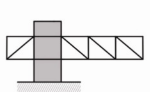
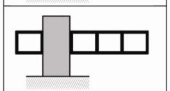
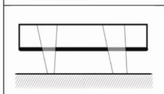
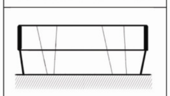
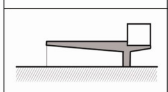
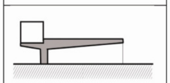
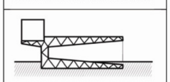
	CONCEPT	CONSTRUCTIE			BOUWFYSICA			
		Type	Materialen	Hoogte constructie	Thermische comfort	Luchtkwaliteit - ventilatie	Akoestisch comfort	Visueel comfort
	Doorgang op straat-niveau, wonen om niveau. Openheid naar omgeving, zowel op straatniveau als op woonniveau.	Vakwerk in combinatie met massieve kern.	Stalen vakwerk Betonnen kern	Min 4 m	Klimaatgevel of dubbele gevel. Integratie van de structuur in de thermische gevel. Vegetatiedak zorgt voor een extra dakisolatie.	Ventilatie via de massieve kern. De massieve kern zorgt voor opwarming/ afkoeling van de ingeblazen lucht.	Enkel de massieve kern zorgt voor absorptie van geluid. Veel glas is negatief voor de akoestiek.	Open zicht vanaf niveau. Groot zicht van binnen naar buiten, maar ook veel inkijk. Zonnewering is noodzakelijk door grote ramen.
		Vierendeelligger in combinatie met massieve kern.	Stalen ligger Betonnen kern	Min 3,5 m			Enkel de massieve kern zorgt voor absorptie van geluid. Meer structuur, dus minder glas, wat positiever is.	Open zicht vanaf niveau. Groot zicht van binnen naar buiten, inkijk beperkter. Zonnewering is noodzakelijk door grote ramen.
	Parkeren en wonen / werken op gescheiden niveaus. Gesloten volume binnen stedelijke context, met enkele patio's voor lichten en zichten.	Profielen die tussen de kolommen (patio's) liggen. Grote overkragingen.	Stalen profielen, betonnen gewelven tussen balken.	Profielen zijn +/- 60 cm hoog.	Betonnen wanden hebben grote capaciteit. Glasgevels in patio's inrichten als klimaatgevels om koudegevoel aan ramen te voorkomen. Verwarming via lage temperatuur-vloerverwarming.	Via patio's in combinatie met klimaatgevels.	Veel massieve wanden, dus hoge absorberende kwaliteiten. Enkel opletten voor overdracht van trillingen in het beton.	Zeer weinig inkijk, hoge privacy. Patio's zorgen voor lichtinval, en enkele kijken uit op de achterliggende tuin.
		Wanden zijn de balken, vloeren dragen tussen de balken/wanden.	Voorgespannen betonnen balken. Betonnen gewelven als vloerelementen.	Balken hebben hoogte van verdieping, dus geen verloren hoogte.				
	Wonen als tegengewicht van het werken.	Halve portiek	Portiek in staal, hout of beton. Zware betonnen funderingen nodig.	Beton: 2 m Hout: 2 m Staal: 1 m	Vloerverwarming en vegetatiedak. Directe bezonning in woning.		Door grote glazen ramen zijn er zeer weinig absorberende materialen. Akoestiek dient opgeloste te worden door de materialen in de ruimte.	Veel privacy voor de woning. Uitzicht vanaf de woning over de groene omgeving. Mindere toegankelijkheid naar bureau.
					Vloerverwarming en vegetatiedak. Enkel bezonning in de woning via het dak.			Veel privacy voor de woning. Uitzicht vanaf de woning over de groene omgeving. Betere toegankelijkheid voor het bureau.
		U-vormige vakwerkstructuur	Stalen vakwerk	2 m				

Fig. 3: Evaluation through matrix of criteria (example from the work of Bart De Decker en Glenn De Hondt).

The typical relation teacher/student makes it hard as teacher to take up the role of co-designing engineer. Even being in their last year, students still doubt their own design maturity: the quality of their design is only as good as the teacher says. This attitude sometimes prevents the students to act as full-fledged co-designers, and hinders the interdisciplinary collaboration to start up. In a future seminar this issue might be counteracted by providing an extra teacher, responsible for the architectural qualities of the student's design.

An early collaboration between engineer and architect has some specific characteristics. At the start of the design process, when the architectural overall concept is still being developed, a clear shape of the building is still missing. In this phase, it is often not feasible to propose an appropriate structural concept. Still, structural input can be very useful, but it needs to be of a relevant nature.
Students often present their architectural concepts through images and analogies of other buildings (Fig.4). I believe that a catalogue of structural concepts exemplified by architecturally qualitative buildings, can be a guidance and an inspiration for the design process. The taxonomy of this catalogue is then to serve the architectural and not the structural design process. This catalogue has for example, a different nature than the work of Engel (Engel & Rapson 1967), which lacks materialisation of the structures and examples of the built reality, and is constructed from an engineering point of view.

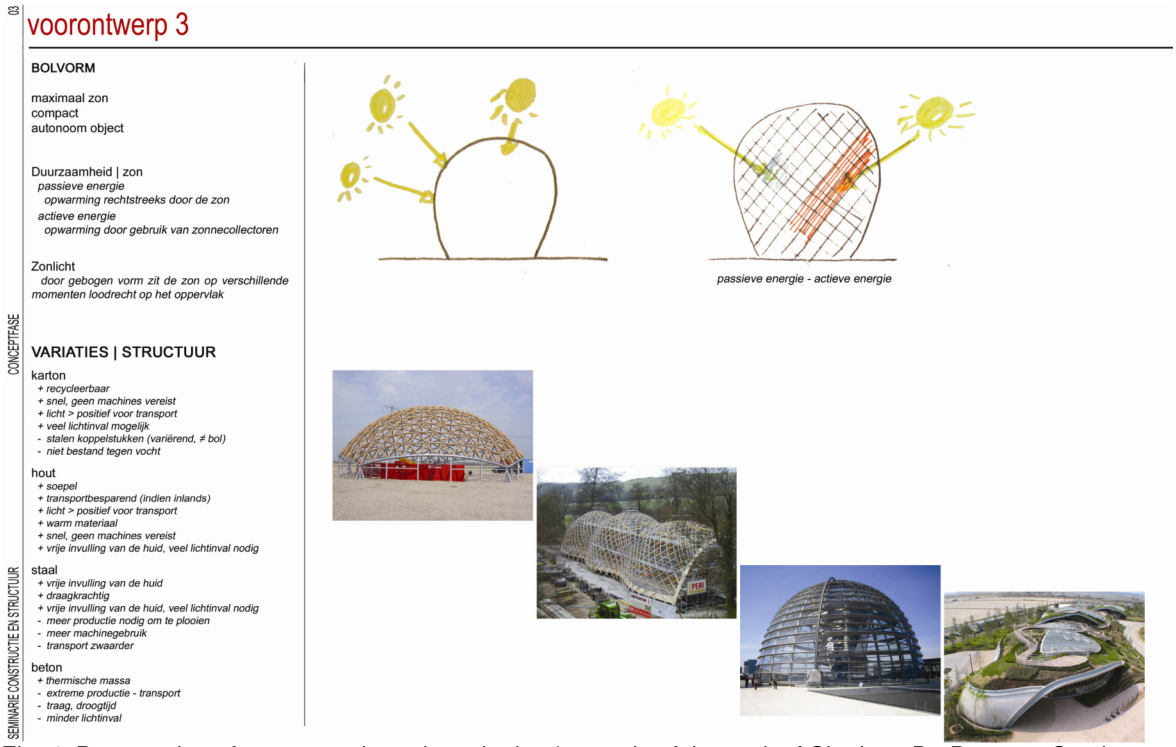


Fig. 4: Presentation of a concept through analogies (example of the work of Charlotte De Baets en Sarah Cuveele).

Another aspect of this early collaboration is the more abstract communication in concepts and idioms of both disciplines of architecture and engineering sciences. The built reality of materials and dimensions is less present in this stage of the design process. This demands for a certain knowledge of the opposite discipline in order to understand each other (see higher): this knowledge is not only related to the specific lexicon applied within the discipline, but also to its logics. For example, a slender column integrated in the window frame, might be nonexistent as a column to the architect –because it is not expressed as such in the architectural shape-, but for the structural engineer be very much a column because of the weight it is carrying: both use the word 'column' in a different manner, according to the logics of their discipline.

Conclusion

The architect as 'homo universalis', expert in art and sciences, is an outdated concept. The reality (and future) of architectural design lays in interdisciplinary teamwork. The challenge for this kind of collaboration is to generate a team creativity that integrates the different disciplines. This brings about an important responsibility to the different team partners to guarantee a creative contribution to the overall design process.

The architects as well as the engineers need to be prepared for this kind of collaboration during their education, by training them as creative partners within an interdisciplinary design team. Both educational systems are responsible for establishing a professional ethic which guarantees a constructive and creative contribution to the design process.

So within the architectural education, students need to get acquainted to design with the engineers as creative co-designers and not only as experts in dimensioning. This seminar was an explorative step in that direction.

Reference

Engel, H. & Rapson, R., 1967. *Tragsysteme/Structure Systems*, Stuttgart: Deutsche Verlags-Anstalt.